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PATENT ABSTRACTS OF JAPAN

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(71)Applicant : SHIMADA PRECISION KK

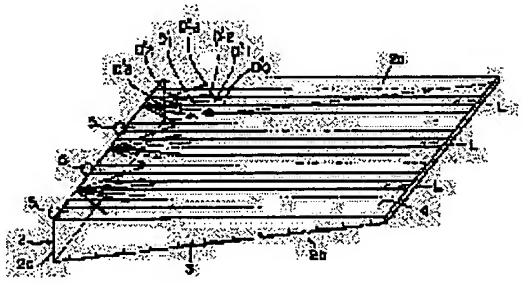
(72)Inventor : OCHIAI SHINICHIRO

(54) LIGHT GUIDE PLATE FOR SPOT LIGHT SOURCE

(57)Abstract:

PROBLEM TO BE SOLVED: To obtain high and uniform luminance over the entire irradiated surface even when a spot light source is used and then to prolong the life of a battery by the reduction of the power consumption of the light source.

SOLUTION: The light guide plate 2 formed of a transparent plate body that lights from three light emitting diodes enter from its thick-side end side 2c is characterized by that the ratio of grating part width and nongrating part width of unit width of a diffraction grating 3 provided on the reverse surface 2b of the light guide 2 is varied, the grating intervals of a diffraction grating 4 provided on the top surface 2a at right angles to the diffraction grating 3 are set to a certain value smaller than the mean grating intervals of the diffraction grating on the reverse surface 2b, and uniform and high luminance is obtained on the top surface 2a of the light guide plate 2.



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* NOTICES *

1.This document has been translated by computer. So the translation may not reflect the original precisely.
2.**** shows the word which can not be translated.
3.In the drawings, any words are not translated.

CLAIMS

[Claim(s)]
[Claim 1] Light from the one or more point light sources of a transparent plate which carry out incidence from an end side at least It is the light guide plate made to diffract. a diffraction grating prepared in a rear face of the above-mentioned plate, and a diffraction grating prepared in the surface of the above-mentioned plate -- While a ratio or a cross-section configuration of grid **** / non-grid **** in unit width of face of a diffraction grating of the above-mentioned rear face is made to change, and a diffraction grating of the above-mentioned rear face and a diffraction grating of the above-mentioned surface cross at right angles and is prepared A lattice spacing of a grid of this surface is set as constant value smaller than an average lattice spacing of a diffraction grating of the above-mentioned rear face. Or a light guide plate characterized by being set as a fixed configuration which diffracts the diffracted light with a high order cross-section configuration of a diffraction grating of the above-mentioned surface with a well head, and obtaining uniform and high brightness in the surface of the above-mentioned light guide plate.
[Claim 2] It is the light guide plate made to diffract. a diffraction grating in which light from the one or more point light sources which carry out incidence from a rear face of a transparent plate was prepared at the rear face of the above-mentioned plate, and a diffraction grating prepared in the surface of the above-mentioned plate -- A light guide plate characterized by being set up so that uniform and high brightness [in / in a lattice spacing of the above-mentioned diffraction grating or a cross-section configuration of the above-mentioned diffraction grating / the surface of the above-mentioned light guide plate] may be obtained while a diffraction grating of the above-mentioned rear face and a diffraction grating of the above-mentioned surface intersect perpendicularly mutually and are prepared.
[Claim 3] A light guide plate characterized by a diffusion board which whitens equalization or the diffracted light which carried out the spectrum being formed in a surface side of the above-mentioned light guide plate by scattered reflection in the diffracted light in a light guide plate according to claim 1 or 2.

[Translation done.]

* NOTICES *

DETAILED DESCRIPTION

[Detailed Description of the Invention]
[0001]
[The technical field to which invention belongs] This invention relates to the light guide plate used for back lights and luminescence induction boards, such as a liquid crystal display.
[0002]
[Description of the Prior Art] Recently, these people proposed the thing as shown in drawing 6 as plane illumination equipment used for the back light of a liquid crystal display (JP,09-325218,A). The light guide plate 32 which consists of transparence plastic resin with which this plane illumination equipment 31 was formed in the lower part of the liquid crystal display panel 40, and the diffraction grating 33 was formed in rear-face 32b, The fluorescence pipe 34 with the cold cathode or the semi-hot electrode as the light source arranged along with heavy-gage side edge side 32c of this light guide plate 32, It consists of a prism sheet 37 for condensing arranged in parallel with the surface side of the reflector 35 which covers so that except for surface 32a of a light guide plate and the fluorescence pipe 34 may be surrounded, and reflects light, the diffusion board 36 arranged in parallel with the surface 32a side of a light guide plate, and this diffusion board 36.
[0003] Fabrication of the above-mentioned diffraction grating 33 is carried out to rear-face 32b which inclines at the angle of 0.5 degrees - 5 degrees as a detailed marked line slot so that the light which carries out incidence to an abbreviation horizontal can be received from the fluorescence pipe 34 on the whole surface, and the diffracted light of a low degree by the relational expression (1) of diffraction mentioned later is an abbreviation perpendicular from surface 32a of a light guide plate, and the lattice spacing d is set up so that outgoing radiation may be carried out in accordance with the direction of total reflection. Moreover, the ratio of grid **** / non-grid **** in each unit width of face typically shown all over drawing of a diffraction grating 33 in the 11 sections (thick wire division manager / thin line division manager of each section) be set up so that it may become large gradually, as it separate from ****32c so that the amount of diffracted lights may increase according to reduction of the attainment quantity of light from the fluorescence pipe 34. In addition, the above-mentioned section is about 1000 pieces farther than 11 pieces mostly in fact.
[0004] With the above-mentioned conventional plane illumination equipment 31, the white light which came out of the fluorescence pipe 34 goes into a light guide plate 32 from ****32c at an abbreviation horizontal. The lattice spacing d prepared all over this is diffracted by collaboration of the smooth side where it adjoins between the dozens of microns (0.1-10 micrometers) marked line slots of a majority of diffraction gratings 33 from submicron one, and the synergism in the whole surface of rear-face 32b which inclines at the angle of 0.5 degrees - 5 degrees. Outgoing radiation of degree (for example, the 1-3rd order) the diffracted light is carried out to an abbreviation perpendicular from surface 32a of a light guide plate 32 like the arrow head in drawing. reinforcement -- low -- one conventional side is as large as 0.16mm, as compared with many conventional triangular pyramid prism sides which carry out total reflection of the light according to an individual as the sum of a light corpuscle in geometrical optics, without cooperating with a next door, it is markedly alike, and the outgoing radiation light of high intensity is obtained. In addition, since the diffraction efficiency (ratio to the incident light reinforcement of diffracted-light reinforcement) of grid **** / non-grid **** in the unit width of face of a diffraction grating 33, i.e., a grid, is large as it separates from ****32c by the side of the fluorescence pipe 34, the decrease of the quantity of light in accordance with separating from the light source is balanced, and the amount of diffracted lights increases. In this way, surface 32a of a light guide plate 32 is high brightness, and is compared very much with homogeneity.
[0005] In addition, although the diffracted light carries out the spectrum of it like the arrow heads R, G, and B in drawing 6 with the relational expression (1) of diffraction mentioned later since the white light which comes out of the

fluorescence pipe 34 has the spectrum distribution which has a peak in blue (B), green (G), and red (R) Since it changes to the original white light, it is condensed with the prism sheet 37 subsequently to a front face arranged and it goes away by passing along the diffusion board 36 arranged in the front face, a high brightness deer is also compared with homogeneity from a lower part by the white light without the spectrum of 40 liquid crystal display panel. Moreover, since except for the surface of a light guide plate 32 and the fluorescence pipe 34 are covered by the reflector 35, incidence of most light of the fluorescence pipe 34 can be altogether carried out to a light guide plate 32, and the liquid crystal display panel 40 is further compared with high brightness.

[0006] The light guide plate which has a d= 3-micrometer diffraction grating using the metal mold which carried out the marked line of the pattern with ultra-fine processing technology as the high brightness of the above-mentioned light guide plate 32 and an example of an experiment of uniform lighting was manufactured, and as a result of measuring surface brightness with a location of 100mm with the same surface brightness of a light guide plate with the about 300-micrometer conventional printing pattern from the light source side edge side, it has become clear that the twice of the former of the latter are also bright. Therefore, since the back light of high brightness is obtained also with few fluorescence pipes 34 of power consumption, if it applies to the liquid crystal display of a cell drive, the life of a cell can be doubled, and if it applies to the liquid crystal television of a cell drive, as for this light guide plate 32, image appreciation on the bright outdoors will be attained.

[0007]

[Problem(s) to be Solved by the Invention] As for the above-mentioned conventional light guide plate 32 which these people proposed, it is the premise of high brightness and uniform field-like lighting that the fluorescence pipe 34 extends as the line light source so to speak along with the **** 32c. However, it originated in miniaturization of the light guide plate 32 accompanying the miniaturization of the liquid crystal display panel 40, or the demand of power consumption reduction, and the fluorescence pipe 34 could not be used, but the case where a light emitting diode etc. is small and a back light must be constituted using some point light sources of power saving has increased. If the light is arranged and switched on to heavy-gage side edge side 32c of the above-mentioned conventional light guide plate 32 as shown in drawing 2 , a place three light emitting diodes Only by the three bright lines L prolonged in a straight line in a longitudinal direction from each light emitting diode appearing in surface 32a of a light guide plate 32 This brightness cannot be extended in a longitudinal direction, but the pars intermedia of the adjacent bright lines L and L becomes dark, and there is a problem that size cannot illuminate a liquid crystal display panel about 2x4 inches or more to high brightness and homogeneity.

[0008] Then, the purpose of this invention is to offer the light guide plate which can continue and obtain uniform brightness to the whole illumination side highly, as a result can also attain reinforcement of the cell by reduction of the power consumption of the light source, even if it uses the point light source by preparing a diffraction grating so that the bright line of the longitudinal direction by the point light source can be expanded to the surface of a light guide plate in a longitudinal direction.

[0009]

[Means for Solving the Problem] In order to attain the above-mentioned purpose, invention of claim 1 Light from the one or more point light sources of a transparent plate which carry out incidence from an end side at least It is the light guide plate made to diffract. a diffraction grating prepared in a rear face of the above-mentioned plate, and a diffraction grating prepared in the surface of the above-mentioned plate -- While a ratio or a cross-section configuration of grid **** / non-grid **** in unit width of face of a diffraction grating of the above-mentioned rear face is made to change, and a diffraction grating of the above-mentioned rear face and a diffraction grating of the above-mentioned surface cross at right angles and is prepared A lattice spacing of a grid of this surface is set as constant value smaller than an average lattice spacing of a diffraction grating of the above-mentioned rear face. Or it is characterized by being set as a fixed configuration which diffracts the diffracted light with a high order cross-section configuration of a diffraction grating of the above-mentioned surface with a well head, and obtaining uniform and high brightness in the surface of the above-mentioned light guide plate.

[0010] When the diffraction grating 3 (marked line slot) of a reflective mold is processed into rear-face 2b of the light guide plate 2 which consists of a transparent plate at intervals of d as an example so that it may illustrate to drawing 1 (A), Although incidence of the light from the point light source in end side 2c of a light guide plate 2 is carried out towards rear-face 2b within space of drawing 1 and it is diffracted by the above-mentioned diffraction grating 3 toward surface 2a like arrow heads D1, D2, and D3 like an arrow head I Between incident light I and the diffracted light D, a degree type (1) is materialized [angle of diffraction / i and] by making m into an integer in an incident angle, making wavelength of theta and light as lambda.

= (sini-sintheta) **m (lambda/d) -- D1, D2, and D3 in (1) drawing show the direction of the diffracted light when setting

m in a top type (1) to 1, 2, and 3, respectively. Since an incident angle over surface 2a becomes larger than the critical angle phi (phi= 42 degrees when [for example,] it is a light guide plate made from an acrylic), total reflection of the primary diffracted light D1 is carried out by surface 2a, the inside of a light guide plate 2 is led to it at the distant place, and since the incident angle over surface 2a is smaller than the critical angle phi, it leaves the secondary diffracted lights [3rd] D2 and D3 from surface 2a to a method of outside. therefore, the incident angle i over rear-face 2b -- adjusting -- low -- the following (for example, m= 3) diffracted light -- surface 2a to this surface, and the abbreviation rectangular cross direction -- going away -- more -- low -- so that the inside of a light guide plate may be led to the following (for example, m= 1) diffracted light at the distant place If a lattice spacing d is appropriately decided to the wavelength lambda of the point light source, surface 2a of a light guide plate 2 will be illuminated very brightly by outgoing radiation light of high intensity left in the direction of an abbreviation normal of this surface 2a, and total reflection light drawn in a light guide plate in an intersection with a vertical plane including the above-mentioned point light source which is the space of drawing 1 . In addition, if many sizes are adjusted, that is, the shape of a quirk of a diffraction grating is changed blazing (blazing), the bright line with highest brightness is obtained and this corresponds to the three bright lines L of drawing 2 , so that the direction of the above-mentioned diffraction which becomes in the direction of an abbreviation normal of surface 2a, and the direction of total reflection of incident light by whenever [in a slot cross section of a marked line slot / tilt-angle] may be in agreement.

[0011] Brightness of the above-mentioned bright line [in / in a ratio or a cross-section configuration of grid **** / non-grid **** in unit width of face of the diffraction grating 3 of rear-face 2b / surface 2a of a light guide plate] L increases, and the light guide plate 2 of claim 1 is made to change so that it may be equalized. That is, a cross-section configuration has become [a ratio of grid **** / non-grid **** in serrate / from a sine wave /, or unit width of face] gradually large, for example as a light guide plate 2 separates from end side 2c by the side of the light source, that is, the quantity of light which arrives from the point light source reduces it. Therefore, since light from the point light source is weakly diffracted by the end side 2c side with much quantity of light and it diffracts so strongly that the quantity of light is on few distant place side, the above-mentioned bright line L of surface 2a of a light guide plate appears by uniform brightness very highly.

[0012] Moreover, since the diffraction grating 4 of a transparency mold which intersects perpendicularly with the diffraction grating 3 of rear-face 2b is formed in surface 2a of the light guide plate 2 of claim 1 by fixed gap d' as shown in drawing 1 (B) which is the b-b line cross section of drawing 1 (A), the diffracted lights D2 and D3 which are visible as the bright line L and carry out outgoing radiation in the direction of an abbreviation normal of surface 2a are diffracted by the diffraction grating 4 of this surface 2a in the case of here, it is shown in drawing 1 (B) -- as -- an incident angle -- i' (= 0) and an angle of diffraction -- from theta', then above-mentioned relational expression (1) - sintheta' -- =**m (lambda/d') It is materialized. then -- the surface -- a diffraction grating -- four -- a lattice spacing -- d -- ' -- a rear face -- a diffraction grating -- three -- an average -- a lattice spacing -- d -- being small -- constant value -- setting up -- having -- **** -- a case -- m -- = -- one -- two -- three -- respectively -- alike -- receiving -- a top -- a formula -- filling -- theta -- ' -- theta -- large -- becoming -- this -- a rear face -- the surface -- a diffraction grating -- four -- depending -- an angle of diffraction -- therefore -- the diffracted light -- that is, -- outgoing radiation -- light -- drawing 1 -- (-- B --) -- and -- drawing 2 -- D -- zero -- ' -- D -- one -- ' -- D -- - -- one -- ' -- D -- two -- ' -- D -- - -- two -- ' -- D -- three -- ' -- D -- - -- three -- ' -- being shown -- as -- large -- spreading -- adjoining each other -- the bright line -- L -- L -- between -- uniform high and brightness -- illuminating -- consequently since reinforcement of the diffracted light of an outside which spreads more greatly of drawing 1 (B) increases on the other hand when m is set as fixed configurations, such as a serration (refer to drawing 4 (D)) which a cross-section configuration of the surface diffraction grating 4 is efficient in the high order large diffracted light at the above-mentioned relational expression (1), and is diffracted and which adjusted a dental angle, for example, -- the same -- homogeneity and high -- brightness illumination side 2a is obtained.

[0013] A point that technique by diffraction grating of this invention essentially differs from the conventional multiple prism which carries out total reflection of the light according to an individual, without each prism working together Lattice spacings d are 1/100 of order, comparing with a length of one side of the above-mentioned prism with submicron one to dozens of microns (0.1-10 micrometers). it is that a smooth side where it adjoins between many detailed marked line slots boils light as a wave motion markedly multiplicatively cooperatively, and can diffract strongly, it is markedly alike, and illumination side 2a of quantity brightness is obtained. In addition, a light guide plate with such a diffraction grating can machine for example, a marked line slot inside, or at the rear face of shaping by metal mold which lined a hologram electrocasting film of a diffraction grating, or a light guide plate, it can direct-machine, or it can print a marked line slot, or can stick and make a film by printing or hologram.

[0014] Invention of claim 2 light from the one or more point light sources which carry out incidence from a rear face of

a transparent plate a diffraction grating prepared in a rear face of the above-mentioned plate, and a diffraction grating prepared in the surface of the above-mentioned plate, while it is the light guide plate made to diffract, and a diffraction grating of the above-mentioned rear face and a diffraction grating of the above-mentioned surface intersect perpendicularly mutually and are prepared It is characterized by being set up so that uniform and high brightness [in / in a lattice spacing of the above-mentioned diffraction grating or a cross-section configuration of the above-mentioned diffraction grating / the surface of the above-mentioned light guide plate] may be obtained.

[0015] Since a light guide plate of claim 2 has the point light source in a rear-face side of a transparent plate, both diffraction gratings prepared in the surface and a rear face of this plate by intersecting perpendicularly mutually serve as a transparency mold. By diffraction grating of a rear face of the above-mentioned plate, it is diffracted [as shown in drawing 1 (B),] so that light from the above-mentioned point light source becomes high order according to relational expression (1) of diffraction as stated above in a field which intersects perpendicularly with a marked line slot of this diffraction grating, and it may spread in whenever [big square], and it makes the train P-2 of the luminescent spot as shown in drawing 5 , P-1, and P0, P1 and P2 on the surface of a plate. Moreover, the diffracted light from a rear face which makes these luminescent spots By diffraction grating of the surface of a plate, in a straight line which intersects perpendicularly with each marked line slot of this diffraction grating, and a plane made from the above-mentioned diffracted light It diffracts, as similarly shown in drawing 1 (B), and it is the group of a train of the luminescent spot of drawing 5 as a result on the surface of a plate. -- ;P. -21, P-11, P01, P11, P12 ;P -2, P-1, P0, P1, P2 ;P -2-1, P-1-1, P0-1, P1-1, P2-1; -- is made. A lattice spacing of a diffraction grating of the above-mentioned rear face and the surface or a cross-section configuration of a diffraction grating is distributed in a pitch with a group of a train of the above-mentioned luminescent spot suitable on the surface of [whole] a plate, and uniform and high brightness in the surface of a light guide plate is obtained.

[0016] A light guide plate of claim 3 is characterized by a diffusion board which whitens equalization or the diffracted light which carried out the spectrum being formed in a surface side of the above-mentioned light guide plate by scattered reflection in the diffracted light.

[0017] A spectrum is carried out and outgoing radiation is carried out so that from relational expression (1) of diffraction, and the diffracted light may illustrate by the arrow heads R, G, and B of drawing 6 . [be / it / the white light in which the light source contains light of the various wavelength lambda] A spectrum which carries out outgoing radiation is changed into the original white light by passing along a diffusion board formed in a surface side. Moreover, when the diffracted light passes that the light source is the homogeneous light along a diffusion board, it becomes homogeneity further. Therefore, even if it uses a small number of homogeneous light or uses the light source of the white light, the surface of a light guide plate can be further illuminated by homogeneity and high brightness according to much more uniform monochrome or the white light which does not carry out a spectrum.

[0018]

[Embodiment of the Invention] Hereafter, the gestalt of implementation of illustration explains this invention to details. Drawing 2 is the perspective diagram showing the gestalt of 1 operation of the light guide plate of claim 1 used for the back light of a liquid crystal display. The light guide plate 2 which consists of transparence plastic resin Rear-face 2b inclines at the angle of 0.5 degrees - 5 degrees to surface 2a so that the light which carries out incidence to an abbreviation horizontal can be received from three light emitting diodes 5 formed in heavy-gage side edge side 2c as the point light source on the whole surface. While having the diffraction grating 3 by which fabrication was carried out to this rear-face 2b as a detailed marked line slot, it has the diffraction grating 4 by which fabrication was carried out by intersecting perpendicularly with the diffraction grating 3 of rear-face 2b at surface 2a. As the relational expression (1) of diffraction already described, the diffracted light of a low degree is an abbreviation perpendicular from surface 2a, and the lattice spacing d of a diffraction grating 3 is set up so that outgoing radiation may be carried out in accordance with the direction of total reflection. Moreover, the ratio of grid **** / non-grid **** in the unit width of face of a diffraction grating 3 is set up so that it may become large gradually, as it separates from ****2c so that the amount of diffracted lights may increase according to reduction of the range from light emitting diode 5. Here, unit width of face is the sum of one grid **** and one non-grid ****, and is the width of face of the unit section. Since the 11 sections which have the unit width of face shown typically are prepared, the thick wire portion in each section is comparatively got blocked in it, so that the thick wire portion of each section and non-grid **** are shown by the thin line portion of each section and grid **** separates in rear-face 2b of the light guide plate 2 of drawing 2 from ****2c, and grid **** is increasing, he can understand that the amount of diffracted lights increases. In addition, although the number of the above-mentioned sections was made into 11 pieces on [of explanation] expedient, it is many [far] numbers in fact, for example, is about 1000 pieces in one example. In addition, although the diffraction grating 3 of rear-face 2b made the grid section and the non-grid section right and left of each unit width of face for 2 minutes and prepared them in them

with the gestalt of this operation, both are prepared by turns into one unit width of face, and the ratio of specific grid **** / non-grid **** may be made to be obtained by the unit width of face. Moreover, the ratio of grid **** / non-grid **** can be changed to arbitration, as long as it is not necessary to make it increase gradually as it not necessarily separates from ****2c like drawing 2 , and the uniform bright line is obtained by surface high brightness.

[0019] On the other hand, as for the diffraction grating 4 of surface 2a, lattice spacing d' is set as the small constant value of the abbreviation one half of the average lattice spacing d of the diffraction grating 3 of rear-face 2b. the above -- a rear face -- a diffraction grating -- three -- depending -- the bright line -- L -- drawing 1 -- (-- B --) -- drawing 2 -- D -- zero -- ' -- D -- one -- ' -- D -- - -- one -- ' -- D -- two -- ' -- D -- - -- two -- ' -- D -- three -- ' -- D -- - -- three -- ' -- being shown -- as -- a longitudinal direction -- large -- spreading -- making -- adjoining each other -- the bright line -- L -- L Although the diffraction gratings 3 and 4 of surface 2a and rear-face 2b are fabricated with the gestalt of this operation by a light guide plate and coincidence using the metal mold with which a lattice spacing d and d' are several micrometers, and machined the marked line slot inside A gap d and d' can create the diffraction grating of this invention also by attachment of the diffraction-grating film by in mold shaping, machining of the marked line slot on the rear face of a light guide plate, or printing and the hologram on the rear face of a light guide plate that interpolated 0.1-10 micrometers and the hologram film of a diffraction grating. In addition, it can replace with the diffraction grating 4 with above-mentioned lattice spacing d' of surface 2a, and can consider as a diffraction grating with the cross-section configuration of a serration shown in drawing 4 (D) which adjusted the dental angle so that m might be efficient and might diffract the high order large diffracted light with the relational expression (1) of diffraction. in this case -- since the reinforcement of the high order diffracted light which spreads outside at a big angle increases -- **** -- the same -- homogeneity and high -- brightness illumination side 2a is obtained.

[0020] Drawing 3 shows an example of a liquid crystal display which used the light guide plate 2 of drawing 2 for the back light, and this liquid crystal display is formed in sequential parallel at the liquid crystal display panel 40 and this lower part, and consists of a diffusion board 36 which equalizes further the diffracted light diffused in homogeneity at the whole surface 2a by the diffraction grating 4 of the surface of the above-mentioned light guide plate 2 by scattered reflection, an above-mentioned light guide plate 2, and plane illumination equipment 1 which consists of a reflector 35 which reflects light. Since the above-mentioned each part material except a light guide plate 2 is the same as the conventional example stated by drawing 6 , it gives the same number to the same member, and omits explanation. In addition, the reflector 35 is covered so that except for surface 2a of a light guide plate 2 and light emitting diode 5 may be surrounded like drawing 6 .

[0021] The plane illumination equipment 1 with the light guide plate 2 of the above-mentioned configuration illuminates the liquid crystal display panel 40 as follows. The homogeneous light which came out of light emitting diode 5 goes into a light guide plate 2 from ****2c at an abbreviation horizontal. Collaboration of the smooth side where it adjoins between the marked line slots of a majority of diffraction gratings 3 prepared all over this diffracts in the whole surface of rear-face 2b which inclines at the angle of 0.5 degrees - 5 degrees. reinforcement -- low -- degree (for example, 2 or 3rd order) the diffracted light -- the direction of an abbreviation normal of surface 2c of a light guide plate 2 -- going -- that strong -- low -- degree (for example, 1st order) the diffracted light can draw the inside of a light guide plate 2 by total reflection. that is, it is more markedly [than that a diffraction grating 3 is detailed at 1/100 of order, and the case where it is based on the triangular pyramid prism of the former which carries out total reflection of the light according to an individual as the sum of a light corpuscle only in geometrical optics, without one side being as large as 0.16mm since marked line / many / slot acts multiplicatively cooperatively, and cooperating with a next door etc.] alike, and the diffracted light of high intensity is obtained. Moreover, since the diffraction efficiency (ratio to the incident light reinforcement of diffracted-light reinforcement) of grid **** / non-grid **** in the unit width of face of a diffraction grating 3, i.e., a grid, is large as it separates from ****2c of light emitting diode 5, the decrease of the quantity of light in accordance with separating from light emitting diode is balanced, and the amount of diffracted lights increases. Therefore, if there is no diffraction grating 4 of the surface of a light guide plate 2, the uniform bright line L (refer to drawing 2) will appear in surface 2a by the high brightness prolonged from each light emitting diode 5.

[0022] However, since the diffraction grating 4 which intersects perpendicularly with the diffraction grating 3 of rear-face 2b as shown in drawing 1 (B) and drawing 2 is formed in surface 2a of a light guide plate 2 by fixed gap d', the diffracted lights D2 and D3 which are visible as the above-mentioned bright line L are diffracted by the diffraction grating 4 of surface 2a in the case of outgoing radiation. Here, since theta', then incident angle i' are 0 about an angle of diffraction as shown in drawing 1 (B), it is from the relational expression (1) of above-mentioned diffraction. - sintheta'=**m (lambda/d') It is materialized. since lattice spacing d' of the surface diffraction grating 4 is set as constant value smaller than the average lattice spacing d of the diffraction grating 3 on the back -- m= -- theta' which 2 and 3 are alike, respectively, and receives and fills a top type becomes larger than theta, and this means that whenever [by the

surface diffraction grating 4 / angle-of-diffraction] is larger than a rear face. therefore -- the diffracted light -- that is, -- outgoing radiation -- light -- drawing 1 -- (-- B --) -- and -- drawing 2 -- D -- zero -- ' -- D -- one -- ' -- D -- - -- one -- ' -- D -- two -- ' -- D -- - -- two -- ' -- D -- three -- ' -- D -- - -- three -- ' -- being shown -- as -- large -- spreading -- the surface -- two -- a -- adjoining each other -- the bright line -- L -- L -- between -- uniform Furthermore, since the diffusion board 36 is formed above the light guide plate 2 like drawing 3 , it is equalized further and the diffracted light which passed along the diffusion board 36 illuminates the liquid crystal display panel 40 in homogeneity and high brightness very much from a lower part. In addition, since except for the surface of a light guide plate 2 and light emitting diode 5 are covered by the reflector 35 and incidence of most light of light emitting diode 5 can be altogether carried out to a light guide plate 2, the liquid crystal display panel 40 can be illuminated in high brightness very uniformly and very much. In addition, with the gestalt of the above-mentioned implementation, although the point light source has been arranged only to heavy-gage side edge side 2c of a light guide plate 2, you may arrange the both-ends side of a light guide plate in order to raise the brightness of an illumination side.

[0023] Drawing 4 shows typically the brightness in surface 2a of a light guide plate 2, i.e., the reinforcement of the diffracted light, and the well-known relation between the lattice spacing of a diffraction grating 3, and a cross-section configuration. However, in drawing 4 , incidence of the light is not carried out into a board from the end face of a light guide plate as mentioned above, but it is carrying out incidence to the light guide plate at the abbreviation perpendicular. In addition, Mr. T.K. gay load (T. KGaylord) announces this drawing in the diffracted-light study work shop held in U.S. Georgia Institute of Technology in March, this year. Although diffraction will arise only in a specific degree like drawing 4 (B) if diffraction will arise like drawing 4 (A) to a high order number (refer to m of the relational expression (1) of diffraction) if a lattice spacing is large, but its lattice spacing is narrow while the diffraction efficiency of each degree is low, the diffraction efficiency is high. Next, in the case of the sine wave like drawing 4 (C), diffraction efficiency is low so that a cross-section configuration may be well seen to a hologram diffraction grating, and the serrate case like drawing 4 (D) makes in agreement the direction of the total reflection of incident light in the direction of the diffracted light, a blaze grid as stated above can be made, diffraction efficiency is high, and when it has the shape of a step like drawing 4 (E) called binary diffraction grating, diffraction efficiency becomes low so that it may see to the diffraction grating of machining well. furthermore, the increase of the ratio of grid **** to non-grid (non-marked line slot) **** [in / as drawing 2 described / the unit width of face of a light guide plate] -- if a decrease is carried out -- the increase of the area of a diffraction grating -- since a decrease is carried out -- the increase of diffraction efficiency -- a decrease is carried out. Therefore, although the ratio of grid **** / non-grid **** in the unit width of face of a diffraction grating 3 was changed along with the longitudinal direction of a light guide plate and the brightness of surface 2a of a light guide plate was equalized with the gestalt of the above-mentioned implementation, equalization of brightness can also be attained by changing the cross-section configuration of a diffraction grating similarly.

[0024] Drawing 5 is the perspective diagram showing the gestalt of 1 operation of the light guide plate of claim 2. while receiving the light which carries out incidence from the single light emitting diode 5 formed in the central lower part of rear-face 12b as the one or more point light sources, fabrication of the light guide plate 12 which consists of transparence plastic resin and presents a thin tabular rectangular parallelepiped was carried out as a detailed marked line slot so that it might intersect perpendicularly with rear-face 12b and surface 12a mutually -- it has both the diffraction gratings 13 and 14 of a transparency mold. Lattice spacing d' of the lattice spacing d of a diffraction grating 13 and a diffraction grating 14 is set as constant value so that uniform and high brightness may be obtained in surface 12a of a light guide plate 12 in consideration of the wavelength lambda of the light emitting diode of the relational expression (1) of diffraction etc. The relation between the above-mentioned lattice spacing d, d', and the flare of the diffracted light has so large that a lattice spacing is narrow as the paragraph [0022] described a flare, and its flare is so small that a lattice spacing is large. Although the above-mentioned light guide plate 12 is not illustrated, either, it constitutes the plane illumination equipment which illuminates the liquid crystal display panel 40 from a lower part together with the same diffusion board 36 and a reflector 35 with drawing 3 having described.

[0025] The light guide plate 12 of the above-mentioned configuration illuminates the liquid crystal display panel 40 as follows. Incidence of the light of light emitting diode 5 is perpendicularly carried out from rear-face 12b of a light guide plate 12. By the diffraction grating 13 It diffracts [as shown in drawing 1 (B),] so that it becomes high order according to the relational expression (1) of diffraction in the field which intersects perpendicularly with the marked line slot of this diffraction grating, and it may spread in whenever [big square], and the train P-2 of the luminescent spot as shown in surface 12a of a light guide plate 12 at drawing 5 , P-1, and P0, P1 and P2 are made. Moreover, the diffracted light from rear-face 12b which makes these luminescent spots By the diffraction grating 14 of surface 12a of a light guide plate 12, in the straight line which intersects perpendicularly with each marked line slot of this diffraction grating 14, and the plane made from the above-mentioned diffracted light It diffracts, as similarly shown in drawing 1 (B), and it is

the group of the train of the luminescent spot of drawing 5 as a result on the surface of a plate. -- ;P. -21, P-11, P01, P11, P12 ;P -2, P-1, P0, P1, P2 ;P -2-1, P-1-1, P0-1, P1-1, P2-1; -- is made. Since the lattice spacing d of the diffraction gratings 13 and 14 of the above-mentioned rear face and the surface and d' are distributed in the pitch for the whole surface 12a of a light guide plate 12 with the suitable group of the train of the above-mentioned luminescent spot, the uniform and high brightness in surface 12a of a light guide plate is obtained. In addition, as shown in drawing 5 , when the luminescent spot Pij makes a zero the intersection of the apparent vertical which passes along light emitting diode 5, and surface 12a and sets the diffraction direction according the diffraction direction by the diffraction grating 13 on the back to the diffraction grating 14 of x and the surface to y, an x-coordinate and Suffix j express [Suffix i] a y-coordinate, respectively.

[0026] although there is no drawing example in the upper and lower sides of the above-mentioned light guide plate 12, since the same diffusion board 36 as drawing 3 , the liquid crystal display panel 40, and the reflector 35 are formed in them and the light of the above-mentioned luminescent spot distributed in the suitable pitch for the whole surface 12a is diffused so that it may become homogeneity distribution further, light emitting diode 5 can illuminate a liquid crystal display panel by homogeneity and high brightness further also by the single or the fraction. More generally than the light guide plate 2 stated by drawing 3 the light guide plate 12 of drawing 5 has thick thickness, and although thickness of the part of light emitting diode 5 increases, light emitting diode 5 is not so thick as the conventional fluorescence pipe, and since light emitting diode is formed in the rear face, there is an advantage that surface brightness becomes brighter. In addition, with the gestalt of operation of drawing 5 , although light emitting diode 5 was simplified, it is good as for plurality in this, then the surface of a light guide plate 12 can be illuminated still more brightly.

[0027] Although the diffraction gratings 13 and 14 of rear-face 12b of the light guide plate 12 of drawing 5 and surface 12a adjust a lattice spacing d and d' and obtained the uniform and high brightness in surface 12a, as the paragraph [0019] described the cross-section configuration of a diffraction grating, they can be made serrate and can also obtain uniform and high brightness. In drawing 5 , although fabrication of the diffraction gratings 13 and 14 of rear-face 12b of a light guide plate 12 and surface 12a was carried out, as the paragraph [0019] described these, it can create also by attachment of the diffraction-grating film by in mold shaping, machining of the marked line slot on the rear face of a light guide plate, or printing and the hologram on the rear face of a light guide plate that interpolated the hologram film of a diffraction grating.

[0028] the above -- although the light emitting diode which emits the homogeneous light as the light source was used with any gestalt of operation, if the point light source which emits the white light can also be used and a diffusion board is formed in the surface side of a light guide plate in that case, light which carried out the spectrum to R, G, and B by diffraction is again made to the white light by letting a diffusion board pass, and a liquid crystal display panel can be illuminated good. Furthermore, the light guide plate of this invention can be used suitable for the luminescence induction board which is looked at by not only an above-mentioned liquid crystal display but the ceiling in a building etc. and which printed the mark of an emergency exit on the surface with the point light source to the end side.

[0029]

[Effect of the Invention] By the above explanation so that clearly the light guide plate of this invention according to claim 1 The ratio or cross-section configuration of grid **** / non-grid **** in the unit width of face of the diffraction grating prepared in the rear face of the transparent plate in which the light from [from an end side] the point light source carries out incidence at least is made to change. The diffraction grating of the above-mentioned rear face and the diffraction grating prepared in the surface of a transparent plate cross at right angles, and is prepared. the above -- And since it is set as the fixed configuration in which it is set as constant value with the lattice spacing smaller than the average lattice spacing of the diffraction grating of the above-mentioned rear face, or the cross-section configuration of the diffraction grating of the above-mentioned surface diffracts the high order diffracted light with a well head It diffracts as the uniform bright line with which this diffraction grating and the light from the point light source cross at right angles from the above-mentioned point light source by the diffraction grating on the back first, and is prolonged. Subsequently, it can be high and between the bright lines which are diffracted and adjoin each other can be illuminated by uniform brightness so that it may spread in whenever [big square] in the direction which intersects perpendicularly with this diffraction grating by the surface diffraction grating, and the surface of a light guide plate can be compared with homogeneity by high brightness. therefore -- if it applies to the liquid crystal display which drives this light guide plate by the cell, a liquid crystal television, the luminescence induction board which displays an emergency exit -- the former -- comparing -- a compact -- and it can be markedly alike, bright uniform lighting can be obtained by little power consumption, the life of the light source and a cell can be prolonged, and long-term use can be enabled.

[0030] While the light guide plate of this invention according to claim 2 intersects perpendicularly mutually, the diffraction grating prepared in the rear face of a plate with the transparent transparent plate in which the light from the

one or more point light sources carries out incidence from a rear face, and the diffraction grating prepared in the surface Since it is set up so that uniform and high brightness [in / in the lattice spacing of the above-mentioned diffraction grating or the cross-section configuration of the above-mentioned diffraction grating / the surface of the above-mentioned light guide plate] may be obtained The light from the point light source diffracts to a radial in the field which intersects perpendicularly with the marked line slot by the diffraction grating on the back first, and makes the train of the luminescent spot. Subsequently, since it diffracts to a radial again in the straight line which intersects perpendicularly with each of that marked line slot by the surface diffraction grating, and the plane made from the diffracted light from a rear face and the matrix of the luminescent spot is made, the surface of a light guide plate can be compared with homogeneity by high brightness. therefore -- if it applies to the liquid crystal display which drives this light guide plate by the cell, a liquid crystal television, the luminescence induction board which displays an emergency exit -- the former -- comparing -- a compact -- and it can be markedly alike, bright uniform lighting can be obtained by little power consumption, the life of the light source and a cell can be prolonged, and long-term use can be enabled.
[0031] Since, as for the light guide plate of this invention according to claim 3, the diffusion board which whitens equalization or the diffracted light which carried out the spectrum for the diffracted light by scattered reflection to the surface side of the above-mentioned light guide plate in a light guide plate according to claim 1 or 2 is formed, although it carries out the spectrum of the diffracted light which carries out outgoing radiation from a light guide plate if the point light source is the white light It is changed into the original white light because this spectrum passes along a diffusion board, and if the light source is the homogeneous light, the diffracted light which carries out outgoing radiation will become homogeneity further by passing along a diffusion board. Therefore, even if it uses a small number of homogeneous light or uses the light source of the white light, the surface of a light guide plate can be further illuminated by homogeneity and high brightness according to much more uniform monochrome or the white light which does not carry out a spectrum.

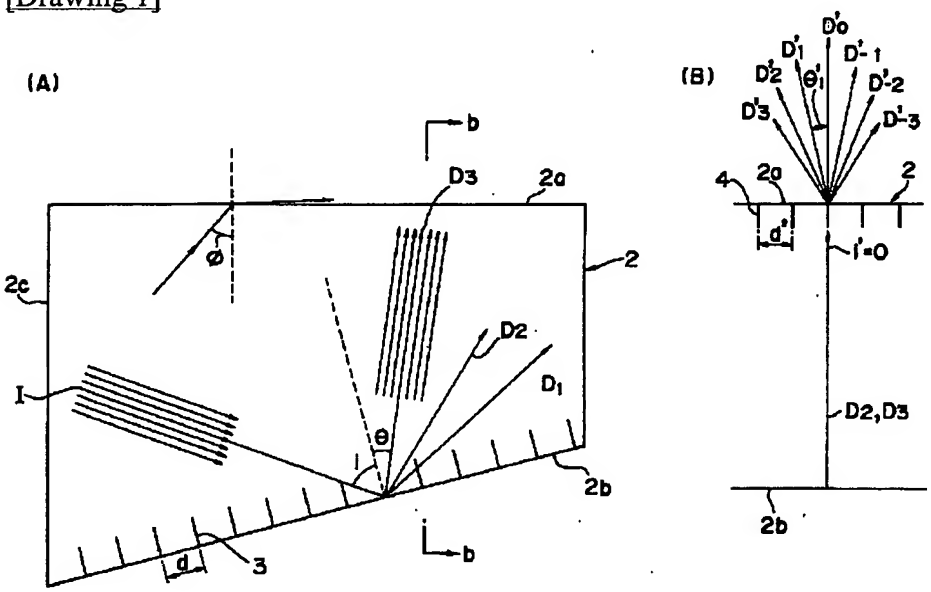
[Translation done.]

* NOTICES *

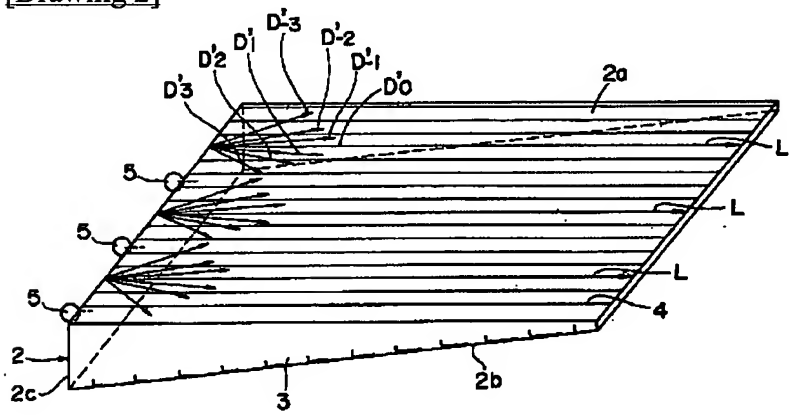
1.This document has been translated by computer. So the translation may not reflect the original precisely.
2.**** shows the word which can not be translated.
3.In the drawings, any words are not translated.

DRAWINGS

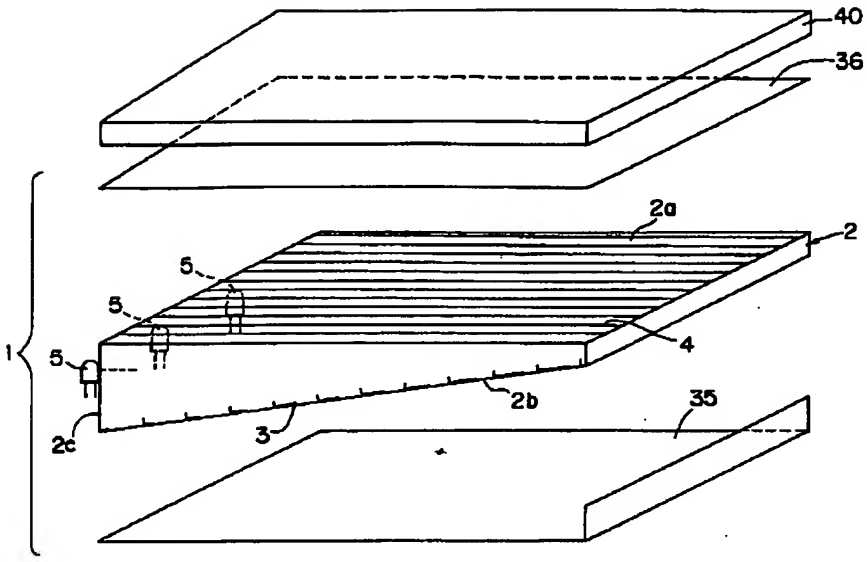
[Drawing 1]



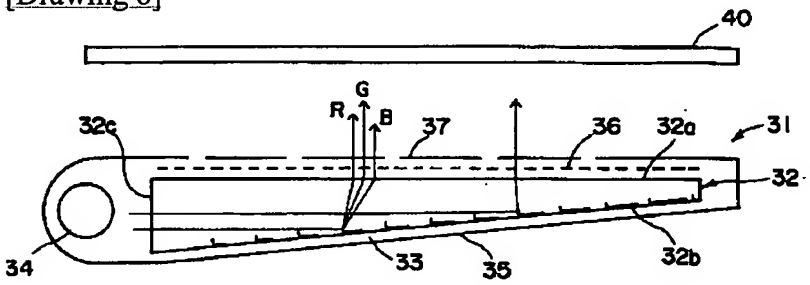
[Drawing 2]



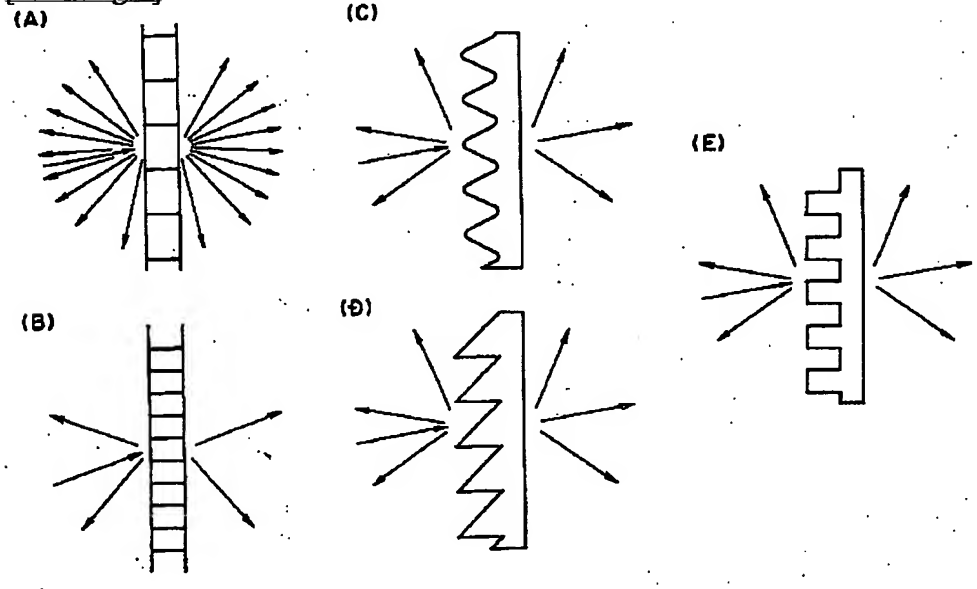
[Drawing 3]



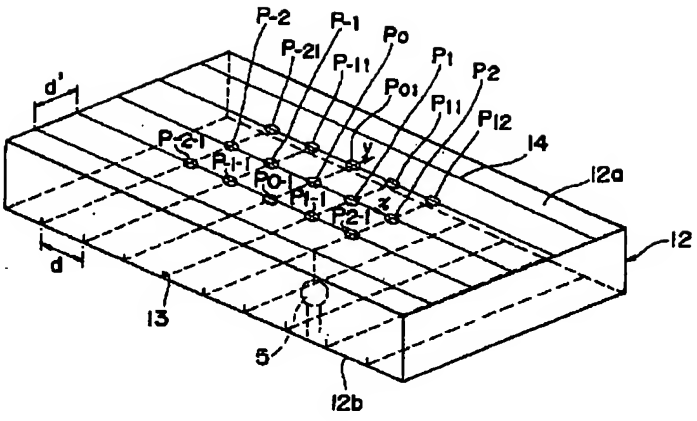
[Drawing 6]



[Drawing 4]



[Drawing 5]



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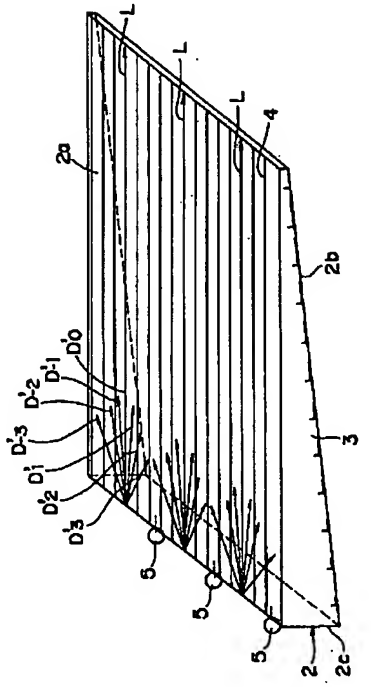
(71)出願人　594067025
嶋田プレシジョン株式会社
京都府京都市伏見区深草小久保町362番地
(72)発明者　落合　真一郎
大阪府八尾市山本町南１丁目７番10号
(74)代理人　弁理士　青山　葆　（外１名）

(54)【発明の名称】　点光源用の導光板

(57)【要約】
【課題】　点光源を用いても高く，かつ均一な輝度を照光面全体に亘って得ることができ、ひいては光源の電力消費の低減による電池の長寿命化も図ることができる導光板を提供する
【解決手段】　厚肉側端辺２cから３つの発光ダイオード５の光が入射する透明な板状体からなる導光板２。この導光板２の裏面２bに設けられた回折格子３の単位幅における格子部幅／非格子部幅の比が、変化せしめられ、上記回折格子３に直交して設けられた表面２aの回折格子４の格子間隔が、裏面２bの回折格子の平均格子間隔よりも小さい一定値に設定されて、導光板２の表面２aにおける均一で高い輝度が得られるようになっている。



【特許請求の範囲】
【請求項１】　透明な板状体の少なくとも一端面から入射する１以上の点光源からの光を、上記板状体の裏面に設けられた回折格子と上記板状体の表面に設けられた回折格子よって回折させる導光板であって、
上記裏面の回折格子の単位幅における格子部幅／非格子部幅の比または断面形状が変化せしめられ、
上記表面の回折格子が、上記裏面の回折格子に直交して設けられるとともに、この表面の格子の格子間隔が上記裏面の回折格子の平均格子間隔よりも小さい一定値に設定され、または上記表面の回折格子の断面形状が高次の回折光を高効率で回折する一定形状に設定されていて、上記導光板の表面における均一で高い輝度が得られるようになっていることを特徴とする導光板。
【請求項２】　透明な板状体の裏面から入射する１以上の点光源からの光を、上記板状体の裏面に設けられた回折格子と上記板状体の表面に設けられた回折格子よって回折させる導光板であって、
上記裏面の回折格子と上記表面の回折格子が、互いに直交して設けられるとともに、上記回折格子の格子間隔または上記回折格子の断面形状が、上記導光板の表面における均一で高い輝度が得られるように設定されていることを特徴とする導光板。
【請求項３】　請求項１または２に記載の導光板において、上記導光板の表面側に、乱反射によって回折光を均一化または分光した回折光を白色化する拡散板が設けられていることを特徴とする導光板。
【発明の詳細な説明】
【０００１】
【発明の属する技術分野】本発明は、液晶表示装置などのバックライトや発光誘導板に用いられる導光板に関する。
【０００２】
【従来の技術】最近、本出願人は、液晶表示装置のバックライトに用いられる平面照光装置として、図６に示すようなものを提案した(特開平０９－３２５２１８号公報)。この平面照光装置３１は、液晶表示パネル４０の下部に設けられ、裏面３２bに回折格子３３が設けられた透明プラスティック樹脂からなる導光板３２と、この導光板３２の厚肉側端辺３２cに沿って配置された光源としての冷陰極またはセミホット電極をもつ蛍光管３４と、導光板の表面３２a以外と蛍光管３４を囲むように覆って光を反射するリフレクタ３５と、導光板の表面３２a側に平行に配置された拡散板３６と、この拡散板３６の表面側に平行に配置された集光用のプリズムシート３７からなる。
【０００３】上記回折格子３３は、蛍光管３４から略水平に入射する光を全面で受け得るように0.5°～5°の角度で傾斜する裏面３２bに、微細な刻線溝として成形加工され、その格子間隔ｄは、後述する回折の関係式(1)による低次の回折光が導光板の表面３２aから略垂直でかつ全反射の方向に一致して出射するように設定されている。また、回折格子３３の図中に模式的に１１個の区間で示された各単位幅における格子部幅／非格子部幅(各区間の太線部長／細線部長)の比は、蛍光管３４からの到達光量の減少に応じて回折光量が増加するように、端辺３２cから離れるに従って次第に大きくなるように設定されている。なお、上記区間は、実際には１１個よりも遥かに多く例えば1000個程度である。
【０００４】上記従来の平面照光装置３１では、蛍光管３４から出た白色光が、端辺３２cから略水平に導光板３２に入り、0.5°～5°の角度で傾斜する裏面３２bの全面に当たり、この全面に設けられた格子間隔ｄがサブミクロンから数十ミクロン(0.1～10μｍ)の回折格子３３の多数の刻線溝間の隣接する平滑面の協同,相乗作用によって回折され、強度の低次(例えば１～３次)回折光が図中の矢印の如く導光板３２の表面３２aから略垂直に出射され、従来の一辺が0.16㎜と大きく,隣と協同せずに個別に光を幾何光学的に光粒子の和として全反射する従来の多数の三角錐プリズム面に比して、格段に高強度の出射光が得られる。加えて、回折格子３３の単位幅における格子部幅／非格子部幅,つまり格子の回折効率(回折光強度の入射光強度に対する比)が、蛍光管３４側の端辺３２cから離れるに従って大きくなっているので、光源から離れるに伴う光量減に見合って回折光量が増加する。こうして、導光板３２の表面３２aは、高輝度でかつ非常に均一に照らされる。
【０００５】なお、蛍光管３４から出る白色光は、青(B),緑(G),赤(R)にピークをもつスペクトル分布を有するので、回折光が、後述する回折の関係式(1)により図６中の矢印Ｒ,Ｇ,Ｂの如く分光するが、前面に配置された拡散板３６を通ることによって元の白色光に変わり、次いで前面に配置されたプリズムシート３７で集光されて出ていくので、液晶表示パネル４０が分光のない白色光で高輝度しかも均一に下方から照らされるのである。また、導光板３２の表面以外と蛍光管３４がリフレクタ３５で覆われているので、蛍光管３４の光を殆ど総て導光板３２に入射させることができ、液晶表示パネル４０が一層高輝度に照らされる。
【０００６】上記導光板３２の高輝度かつ均一な照明の実験例として、微細加工技術でパターンを刻線した金型を用いてｄ＝３μｍの回折格子をもつ導光板を製造し、光源側端辺から100㎜の位置での表面輝度を、従来の300μｍ程度の印刷パターンをもつ導光板の同様の表面輝度と比較した結果、前者は後者の２倍も明るいことが判明している。従って、この導光板３２は、電力消費の少ない蛍光管３４でも高輝度のバックライトが得られるから、電池駆動の液晶表示装置に適用すれば電池の寿命を倍増でき、電池駆動の液晶テレビに適用すれば、明るい屋外での映像鑑賞が可能になる。

【０００７】
【発明が解決しようとする課題】本出願人が提案した上記従来の導光板３２は、その端辺３２ｃに沿っていわば線光源として蛍光管３４が延在することが、高輝度かつ均一な面状照明の前提である。しかし、液晶表示パネル４０の小型化に伴う導光板３２のコンパクト化あるいは消費電力節減の要求に起因して、蛍光管３４を用いることができず、発光ダイオードなどの小さくて省電力の点光源を数個用いてバックライトを構成せざるを得ない場合が増えてきた。ところが、例えば、３個の発光ダイオードを上記従来の導光板３２の厚肉側端辺３２ｃに、図２に示すように配置して点灯すると、導光板３２の表面３２ａには各発光ダイオードから長手方向に一直線に延びる３本の輝線Ｌが現れるだけで、この輝きを横方向に拡げることができず、隣り合う輝線Ｌ，Ｌの中間部が暗くなって、サイズが２×４インチ程度以上の液晶表示パネルを高輝度かつ均一に照明することができないという問題がある。
【０００８】そこで、本発明の目的は、導光板の表面に点光源による長手方向の輝線を横方向に拡大できるように回折格子を設けることによって、点光源を用いても高く，かつ均一な輝度を照光面全体に亘って得ることができ、ひいては光源の電力消費の低減による電池の長寿命化も図ることができる導光板を提供することにある。
【０００９】
【課題を解決するための手段】上記目的を達成するため、請求項１の発明は、透明な板状体の少なくとも一端面から入射する１以上の点光源からの光を、上記板状体の裏面に設けられた回折格子と上記板状体の表面に設けられた回折格子よって回折させる導光板であって、上記裏面の回折格子の単位幅における格子部幅／非格子部幅の比または断面形状が変化せしめられ、上記表面の回折格子が、上記裏面の回折格子に直交して設けられるとともに、この表面の格子の格子間隔が上記裏面の回折格子の平均格子間隔よりも小さい一定値に設定され、または上記表面の回折格子の断面形状が高次の回折光を高効率で回折する一定形状に設定されていて、上記導光板の表面における均一で高い輝度が得られるようになっていることを特徴とする。
【００１０】図１（Ａ）に例示するように、透明な板状体からなる導光板２の裏面２ｂに一例として間隔ｄで反射型の回折格子３（刻線溝）が加工されている場合、導光板２の一端面２ｃにある点光源からの光は、矢印Ｉの如く図１の紙面内で裏面２ｂに向けて入射し、上記回折格子３によって矢印D_1，D_2，D_3の如く表面２ａに向かって回折されるが、入射光Ｉと回折光Ｄの間には、入射角をｉ，回折角をθ，光の波長をλ，ｍを整数として、次式(1)が成立する。
$(\sin i - \sin\theta) = \pm m(\lambda / d)$　…(1)
図中のD_1，D_2，D_3は、上式(1)中のｍを夫々１，２，３としたときの回折光の方向を示している。１次の回折光D_1は、表面２ａに対する入射角が臨界角ϕ（例えばアクリル製導光板の場合，ϕ＝42°）よりも大きくなるので、表面２ａで全反射されて導光板２内を遠方へ導かれ、２次，３次の回折光D_2，D_3は、表面２ａに対する入射角が臨界角ϕよりも小さいので、表面２ａから外方へ出ていく。従って、裏面２ｂに対する入射角ｉを調整し、低次（例えば，ｍ＝３）の回折光が表面２ａからこの表面と略直交方向に出ていき、より低次（例えば，ｍ＝１）の回折光が導光板内を遠方へ導かれるように、点光源の波長λに対して格子間隔ｄを適切に決めれば、導光板２の表面２ａが、この表面２ａの略法線方向に出て行く高強度の出射光と導光板内に導かれる全反射光によって、図１の紙面である上記点光源を含む鉛直面との交線において、極めて明るく照らされる。なお、表面２ａの略法線方向になる上記回折の方向と、刻線溝の溝断面における傾斜角度による入射光の全反射の方向が一致するように諸寸法を調整する、つまり回折格子の溝形状をブレージング（blazing）化すれば最も輝度の高い輝線が得られ、これが図２の３本の輝線Ｌに該当する。
【００１１】請求項１の導光板２は、裏面２ｂの回折格子３の単位幅における格子部幅／非格子部幅の比または断面形状が、導光板の表面２ａにおける上記輝線Ｌの輝度が増大し、かつ均一化されるように変化せしめられている。即ち、導光板２は、例えば、光源側の一端面２ｃから離れる，つまり点光源から届く光量が減じるにしたがって、例えば、断面形状が正弦波から鋸歯状に，または単位幅における格子部幅／非格子部幅の比が次第に大きくなっている。従って、点光源からの光は、光量の多い一端面２ｃ側で弱く回折され、光量が少ない遠方側になるほど強く回折されるので、導光板の表面２ａの上記輝線Ｌは非常に高く，かつ均一な輝度で出現する。
【００１２】また、請求項１の導光板２の表面２ａには、図１（Ａ）のｂ－ｂ線断面図である図１（Ｂ）に示すように、裏面２ｂの回折格子３に直交する透過型の回折格子４が一定間隔ｄ'で設けられているので、輝線Ｌとして見え，表面２ａの略法線方向に出射する回折光D_2，D_3は、この表面２ａの回折格子４によって出射の際に回折される。ここで、図１（Ｂ）に示すように、入射角をｉ'（＝０），回折角をθ'とすれば、上述の関係式（１）から$-\sin\theta' = \pm m(\lambda / d')$ が成立する。そこで、表面の回折格子４の格子間隔ｄ'が、裏面の回折格子３の平均格子間隔ｄよりも小さい一定値に設定されている場合は、ｍ＝１，２，３の夫々に対して上式を満たすθ'はθよりも大きくなり、これは裏面よりも表面の回折格子４による回折角度の方が大きいことを意味する。従って、回折光つまり出射光は、図１（Ｂ）および図２のD_0'，D_1'，D_{-1}'，D_2'，D_{-2}'，D_3'，D_{-3}'で示すように大きく拡がって、隣り合う輝線Ｌ，Ｌの間を高く，かつ均一な輝度で照し、その結果、均一かつ高輝度な照光面２ａ

が得られる。一方、表面の回折格子４の断面形状が、上記関係式(１)でｍが大きい高次の回折光を高効率で回折する例えば歯の角度を調整した鋸歯(図４(D)参照)などの一定形状に設定されている場合は、図１(B)のより大きく拡がる外側の回折光の強度が増えるので、同様に均一かつ高輝度な照光面２aが得られる。

【００１３】本発明の回折格子による手法が、各プリズムが協同することなく個別に光を全反射する従来の多面プリズム等と本質的に異なる点は、格子間隔ｄがサブミクロンから数十ミクロン(0.1～10μm)までと上記プリズムの一辺の長さに比して1／100のオーダであり、多数の微細刻線溝間の隣接する平滑面が協同,相乗して波動としての光を格段に強く回折でき、格段に高輝度の照光面２aが得られることである。なお、このような回折格子をもつ導光板は、例えば、刻線溝を内面に機械加工したり回折格子のホログラム電鋳膜を内張りした金型による成形、あるいは導光板の裏面に刻線溝を直接機械加工または印刷したり,印刷やホログラムによる膜を張り付けて作ることができる。

【００１４】請求項２の発明は、透明な板状体の裏面から入射する１以上の点光源からの光を、上記板状体の裏面に設けられた回折格子と上記板状体の表面に設けられた回折格子よって回折させる導光板であって、上記裏面の回折格子と上記表面の回折格子が、互いに直交して設けられるとともに、上記回折格子の格子間隔または上記回折格子の断面形状が、上記導光板の表面における均一で高い輝度が得られるように設定されていることを特徴とする。

【００１５】請求項２の導光板は、透明な板状体の裏面側に点光源があるので、この板状体の表面と裏面に互いに直交して設けられた回折格子は、共に透過型となる。上記点光源からの光は、上記板状体の裏面の回折格子により、既述の回折の関係式(1)にしたがい,図１(B)に示すようにこの回折格子の刻線溝に直交する面内で高次になる程大角度で拡がるように回折し、板状体の表面に例えば図５に示すような輝点の列P_{-2},P_{-1},P_0,P_1,P_2を作る。また、これらの輝点を作る裏面からの回折光は、板状体の表面の回折格子により、この回折格子の各刻線溝と直交する直線と上記回折光で作られる平面内で、同じく図１(B)に示すように回折して、板状体の表面に結果的に図５の輝点の列の組 … ;P_{-21},P_{-11},P_{01},P_{11},P_{12};P_{-2},P_{-1},P_0,P_1,P_2;P_{-2-1},P_{-1-1},P_{0-1},P_{1-1},P_{2-1}; …が作られる。上記裏面と表面の回折格子の格子間隔または回折格子の断面形状は、上記輝点の列の組が板状体の表面全体に適切なピッチで分布して、導光板の表面における均一で高い輝度が得られるようになっている。

【００１６】請求項３の導光板は、上記導光板の表面側に、乱反射によって回折光を均一化または分光した回折光を白色化する拡散板が設けられていることを特徴とする。

【００１７】光源が種々の波長λの光を含む白色光であると、回折の関係式(1)から明らかなように、回折光が図６の矢印Ｒ,Ｇ,Ｂで例示するように分光して出射する。出射する分光は、表面側に設けられた拡散板を通ることによって元の白色光に変えられる。また、光源が単色光であると、回折光は拡散板を通ることによってさらに均一になる。従って、少数の単色光を用いたり,白色光の光源を用いたりしても、導光板の表面を一層均一な単色,または分光しない白色光によってさらに均一かつ高輝度で照らすことができる。

【００１８】

【発明の実施の形態】以下、本発明を図示の実施の形態により詳細に説明する。図２は、液晶表示装置のバックライトに用いられた請求項１の導光板の一実施の形態を示す斜視図である。透明プラスティック樹脂からなる導光板２は、裏面２bが、点光源として厚肉側端辺２cに設けられた３つの発光ダイオード５から略水平に入射する光を全面で受け得るように表面２aに対して0.5° ～5° の角度で傾斜し、この裏面２bに、微細な刻線溝として成形加工された回折格子３を有するとともに、表面２aに、裏面２bの回折格子３に直交して成形加工された回折格子４を有する。回折格子３の格子間隔ｄは、回折の関係式(1)で既に述べたように、低次の回折光が表面２aから略垂直でかつ全反射の方向に一致して出射するように設定される。また、回折格子３の単位幅における格子部幅／非格子部幅の比は、発光ダイオード５からの到達距離の減少に応じて回折光量が増加するように、端辺２cから離れるに従って次第に大きくなるように設定されている。ここで、単位幅とは、１つの格子部幅と１つの非格子部幅との和であり、単位区間の幅である。図２の導光板２の裏面２bには、模式的に示された単位幅を有する１１個の区間が設けられ、格子部幅は各区間の太線部分、非格子部幅は各区間の細線部分で示されており、端辺２cから離れるほど各区間での太線部分の割合,つまり格子部幅が増えていることから、回折光量が増えることが理解できる。なお、上記区間の数は、説明の便宜上１１個としたが、実際には遥かに多い数で、例えば１例では1000個程度である。なお、裏面２bの回折格子３は、本実施の形態では、格子部と非格子部を各単位幅の左右に２分して設けたが、両者を１つの単位幅中に交互に設けてその単位幅に特定の格子部幅／非格子部幅の比が得られるようにしてもよい。また、格子部幅／非格子部幅の比は、必ずしも図２のように端辺２cから離れるにつれて漸増させる必要はなく、表面の高輝度で均一な輝線が得られる限り、任意に変化させることができる。

【００１９】一方、表面２aの回折格子４は、格子間隔ｄ'が裏面２bの回折格子３の平均格子間隔ｄの略半分の小さい一定値に設定されていて、上記裏面の回折格子３による輝線Ｌを、図１(B),図２のD_0',D_1', D_{-1}',D

$_2$', D_{-2}', D_3', D_{-3}'で示すように横方向に大きく拡がらせて、隣り合う輝線L,Lの間を高く,かつ均一な輝度で照すように回折させるようになっている。本実施の形態では、表面2a,裏面2bの回折格子3,4は、格子間隔d,d'が数μmで,内面に刻線溝を機械加工した金型を用いて導光板と同時に成形されるが、本発明の回折格子は、間隔d,d'が0.1～10μm、回折格子のホログラム膜を内挿したインモールド成形、導光板裏面への刻線溝の機械加工、または導光板裏面への印刷やホログラムによる回折格子膜の張付けによっても作成することができる。なお、上記格子間隔d'をもつ表面2aの回折格子4に代えて、回折の関係式(1)でmが大きい高次の回折光を高効率で回折するように歯の角度を調整した図4(D)に示す鋸歯の断面形状をもつ回折格子とすることができる。この場合、大きな角度で外側へ拡がる高次の回折光の強度が増えるので、上述と同様に均一かつ高輝度な照光面2aが得られる。

【0020】図3は、図2の導光板2をバックライトに用いた液晶表示装置の一例を示しており、この液晶表示装置は、液晶表示パネル40と、この下部に順次平行に設けられ、上記導光板2の表面の回折格子4により表面2a全体に均一に拡散した回折光を乱反射によってさらに均一化する拡散板36,上記導光板2,および光を反射するリフレクタ35からなる平面照光装置1とで構成される。導光板2を除く上記各部材は、図6で述べた従来例と同じなので、同じ部材には同一番号を付して説明を省略する。なお、リフレクタ35は、図6と同様に導光板2の表面2a以外と発光ダイオード5を囲むように覆っている。

【0021】上記構成の導光板2をもつ平面照光装置1は、次のように液晶表示パネル40を照らす。発光ダイオード5から出た単色光は、端辺2cから略水平に導光板2に入り、0.5°～5°の角度で傾斜する裏面2bの全面に当たり、この全面に設けられた回折格子3の多数の刻線溝間の隣接する平滑面の協同によって回折され、強度の低次(例えば2,3次)回折光が導光板2の表面2cの略法線方向に向かい、強度のより低次(例えば1次)回折光が全反射で導光板2内を導かれる。つまり、回折格子3は、1/100のオーダで微細かつ多数の刻線溝が協同,相乗して作用するので、一辺が0.16mmと大きく,隣と協同せずに個別に光を単に幾何光学的に光粒子の和として全反射する従来の三角錐プリズム等による場合よりも、格段に高強度の回折光が得られる。また、回折格子3の単位幅における格子部幅／非格子部幅,つまり格子の回折効率(回折光強度の入射光強度に対する比)が、発光ダイオード5の端辺2cから離れるに従って大きくなっているので、発光ダイオードから離れるに伴う光量減に見合って回折光量が増加する。従って、導光板2の表面の回折格子4がなければ、表面2aには各発光ダイオード5から延びる高輝度で均一な輝線L(図2参照)が出現する。

【0022】しかし、導光板2の表面2aには、図1(B),図2に示すような裏面2bの回折格子3に直交する回折格子4が一定間隔d'で設けられているので、上記輝線Lとして見える回折光D_2,D_3は、表面2aの回折格子4によって出射の際に回折される。ここで、図1(B)に示すように、回折角をθ'とすれば、入射角i'が0なので、上述の回折の関係式(1)から $-\sin\theta' = \pm m(\lambda/d')$ が成立する。表面の回折格子4の格子間隔d'は、裏面の回折格子3の平均格子間隔dよりも小さい一定値に設定されているから、m=2,3の夫々に対して上式を満たすθ'はθよりも大きくなり、これは裏面よりも表面の回折格子4による回折角度の方が大きいことを意味する。従って、回折光つまり出射光は、図1(B)および図2のD_0', D_1', D_{-1}', D_2', D_{-2}', D_3', D_{-3}'で示すように大きく拡がって、表面2aの隣り合う輝線L,Lの間を高く,かつ均一な輝度で照らす。さらに、導光板2の上方に図3の如く拡散板36が設けられているので、拡散板36を通った回折光はさらに均一化され、液晶表示パネル40を下方から非常に均一かつ高輝度に照明する。加えて、導光板2の表面以外と発光ダイオード5をリフレクタ35で覆っているので、発光ダイオード5の光を殆ど総て導光板2に入射させることができるので、液晶表示パネル40を非常に均一かつ非常に高輝度に照明することができる。　なお、上記実施の形態では、点光源を導光板2の厚肉側端辺2cのみに配置したが、照光面の輝度を高めるべく、導光板の両端辺に配置してもよい。

【0023】図4は、導光板2の表面2aにおける輝度,つまり回折光の強度と、回折格子3の格子間隔および断面形状の周知の関係を模式的に示している。但し、図4では、光は上述のように導光板の端面から板内に入射するのでなく、導光板に略垂直に入射している。なお、この図は、T.K.ゲイロード(T.K.Gaylord)氏が、今年3月に米国ジョージア工科大学で開かれた回折光学共同研究会において発表したものである。格子間隔が広いと、図4(A)の如く、高次数(回折の関係式(1)のm参照)まで回折が生じるが、各次数の回折効率は低い一方、格子間隔が狭いと、図4(B)の如く、特定の次数でしか回折が生じないが、その回折効率は高い。次に、断面形状が、ホログラム回折格子に良くみられるように図4(C)の如き正弦波の場合は、回折効率が低く、機械加工の回折格子に良くみられるように図4(D)の如き鋸歯状の場合は、入射光の全反射の方向を回折光の方向に一致させて既述のブレーズ格子を作ることができて回折効率が高く、バイナリ回折格子といわれる図4(E)の如きステップ状の場合は、回折効率が低くなる。さらに、図2で述べたように、導光板の単位幅における非格子(非刻線溝)部幅に対する格子部幅の比が増,減すれば、回折格子の面積が増,減するので、回折効率は増,減する。従って、

上記実施の形態では、回折格子３の単位幅における格子部幅／非格子部幅の比を導光板の長手方向に沿って変化させて導光板の表面２aの輝度を均一化したが、回折格子の断面形状を同様に変化させることによって輝度の均一化を図ることもできる。

【００２４】図５は、請求項２の導光板の一実施の形態を示す斜視図である。透明プラスティック樹脂からなり薄い板状の直方体を呈する導光板１２は、１以上の点光源として裏面１２bの中央下方に設けられた単一の発光ダイオード５から入射する光を受けるとともに、裏面１２bと表面１２aに互いに直交するように微細な刻線溝として成形加工された共に透過型の回折格子１３，１４を有する。回折格子１３の格子間隔dおよび回折格子１４の格子間隔d'は、回折の関係式(1)の発光ダイオードの波長λ等を考慮して導光板１２の表面１２aにおいて均一で高い輝度が得られるように一定値に設定されている。上記格子間隔d，d'と回折光の拡がりとの関係は、段落[0022]で述べたように、格子間隔が狭いほど拡がりが大きく、格子間隔が広いほど拡がりが小さい。上記導光板１２も、図示しないが図３で述べたと同様の拡散板３６，リフレクタ３５と一緒に、液晶表示パネル４０を下方から照明する平面照光装置を構成する。

【００２５】上記構成の導光板１２は、次のように液晶表示パネル４０を照らす。発光ダイオード５の光は、導光板１２の裏面１２bから垂直に入射してその回折格子１３により、回折の関係式(1)にしたがい、図１（B）に示すようにこの回折格子の刻線溝に直交する面内で高次になるほど大角度で拡がるように回折し、導光板１２の表面１２aに図５に示すような輝点の列P_{-2}，P_{-1}，P_0，P_1，P_2を作る。また、これらの輝点を作る裏面１２bからの回折光は、導光板１２の表面１２aの回折格子１４により、この回折格子１４の各刻線溝と直交する直線と上記回折光で作られる平面内で、同じく図１（B）に示すように回折して、板状体の表面に結果的に図５の輝点の列の組 … ；P_{-21}，P_{-11}，P_{01}，P_{11}，P_{12}；P_{-2}，P_{-1}，P_0，P_1，P_2；P_{-2-1}，P_{-1-1}，P_{0-1}，P_{1-1}，P_{2-1}；…が作られる。上記裏面と表面の回折格子１３，１４の格子間隔d，d'は、上記輝点の列の組が導光板１２の表面１２a全体に適切なピッチで分布するので、導光板の表面１２aにおける均一で高い輝度が得られる。なお、輝点P_{ij}は、図５に示すように、発光ダイオード５を通る鉛直線と表面１２aの交点を原点とし、裏面の回折格子１３による回折方向をｘ，表面の回折格子１４による回折方向をｙとするとき、サフィックスｉがｘ座標，サフィックスｊがｙ座標を夫々表わす。

【００２６】上記導光板１２の上下には、図示しないが図３と同様の拡散板３６，液晶表示パネル４０，リフレクタ３５が設けられているので、表面１２a全体に適切なピッチで分布する上記輝点の光をさらに均一分布になるように拡散するから、発光ダイオード５が単一または少数でも液晶表示パネルをさらに均一かつ高輝度で照らすことができる。図５の導光板１２は、図３で述べた導光板２よりも一般に厚さが厚く、また発光ダイオード５の分だけ厚さが増えるが、発光ダイオード５は従来の蛍光管ほど厚くなく、また発光ダイオードを裏面に設けているので、表面の輝度がより明るくなるという利点がある。なお、図５の実施の形態では、発光ダイオード５を単一にしたが、これを複数にしてもよく、そうすれば導光板１２の表面を一層明るく照らすことができる。

【００２７】図５の導光板１２の裏面１２bと表面１２aの回折格子１３，１４は、格子間隔d，d'を調整して、表面１２aにおける均一で高い輝度を得るようにしたが、回折格子の断面形状を段落[0019]で述べたように例えば鋸歯状にするなどして均一で高い輝度を得ることもできる。図５では、導光板１２の裏面１２bと表面１２aの回折格子１３，１４を成形加工したが、これらを段落[0019]で述べたように、回折格子のホログラム膜を内挿したインモールド成形、導光板裏面への刻線溝の機械加工、または導光板裏面への印刷やホログラムによる回折格子膜の張付けによっても作成することができる。

【００２８】上記いずれの実施の形態でも、光源として単色光を発する発光ダイオードを用いたが、白色光を発する点光源を用いることもでき、その場合、導光板の表面側に拡散板を設ければ、回折でR，G，Bに分光した光を拡散板を通すことで再び白色光にでき、液晶表示パネルを良好に照らすことができる。さらに、本発明の導光板は、上述の液晶表示装置のみならず、ビル内の天井等に見られる，一端面に点光源をもち表面に非常口のマークを印刷した発光誘導板などにも好適に用いることができる。

【００２９】

【発明の効果】以上の説明で明らかなように、本発明の請求項１に記載の導光板は、少なくとも一端面から点光源からの光が入射する透明な板状体の裏面に設けられた回折格子の単位幅における格子部幅／非格子部幅の比または断面形状が変化せしめられ、上記透明な板状体の表面に設けられた回折格子が、上記裏面の回折格子に直交して設けられ、かつその格子間隔が上記裏面の回折格子の平均格子間隔よりも小さい一定値に設定され、または上記表面の回折格子の断面形状が高次の回折光を高効率で回折する一定形状に設定されているので、点光源からの光が、まず裏面の回折格子により上記点光源からこの回折格子に直交して延びる均一な輝線として回折され、次いで表面の回折格子によりこの回折格子に直交する方向に大角度で拡がるように回折されて隣り合う輝線間を高く，均一な輝度で照らし、導光板の表面を高輝度で均一に照らすことができる。従って、この導光板を電池で駆動される液晶表示装置，液晶テレビ，非常口を表示する発光誘導板などに適用すれば、従来に比してコンパクトかつ格段に少ない消費電力で明るく均一な照明を得るこ

とができ、光源および電池の寿命を延ばし、長期使用を可能にすることができる。

【００３０】本発明の請求項２に記載の導光板は、裏面から１以上の点光源からの光が入射する透明な板状体の透明な板状体の裏面に設けられた回折格子と表面に設けられた回折格子が、互いに直交するとともに、上記回折格子の格子間隔または上記回折格子の断面形状が、上記導光板の表面における均一で高い輝度が得られるように設定されているので、点光源からの光が、まず裏面の回折格子によりその刻線溝に直交する面内で放射状に回折して輝点の列を作り、次いで表面の回折格子によりその各刻線溝に直交する直線と裏面からの回折光で作られる平面内で再び放射状に回折して輝点の行列を作るから、導光板の表面を高輝度で均一に照らすことができる。従って、この導光板を電池で駆動される液晶表示装置，液晶テレビ，非常口を表示する発光誘導板などに適用すれば、従来に比してコンパクトかつ格段に少ない消費電力で明るく均一な照明を得ることができ、光源および電池の寿命を延ばし、長期使用を可能にすることができる。

【００３１】本発明の請求項３に記載の導光板は、請求項１または２に記載の導光板において、上記導光板の表面側に、乱反射によって回折光を均一化または分光した回折光を白色化する拡散板が設けられているので、点光源が白色光なら、導光板から出射する回折光は分光するが、この分光が拡散板を通ることで元の白色光に変えられ、また、光源が単色光であるなら、出射する回折光は拡散板を通ることでさらに均一になる。従って、少数の単色光を用いたり，白色光の光源を用いたりしても、導光板の表面を一層均一な単色，または分光しない白色光によってさらに均一かつ高輝度で照らすことができる。

【図面の簡単な説明】

【図１】　導光板の表，裏面に設けられた回折格子による光の回折を原理的に示す模式図である。

【図２】　本発明の請求項１に記載の導光板の一実施の形態を示す斜視図である。

【図３】　図２の導光板をバックライトに用いた液晶表示装置の概略分解斜視図である。

【図４】　回折光の強度と回折格子の格子間隔および断面形状の関係を示す模式図である。

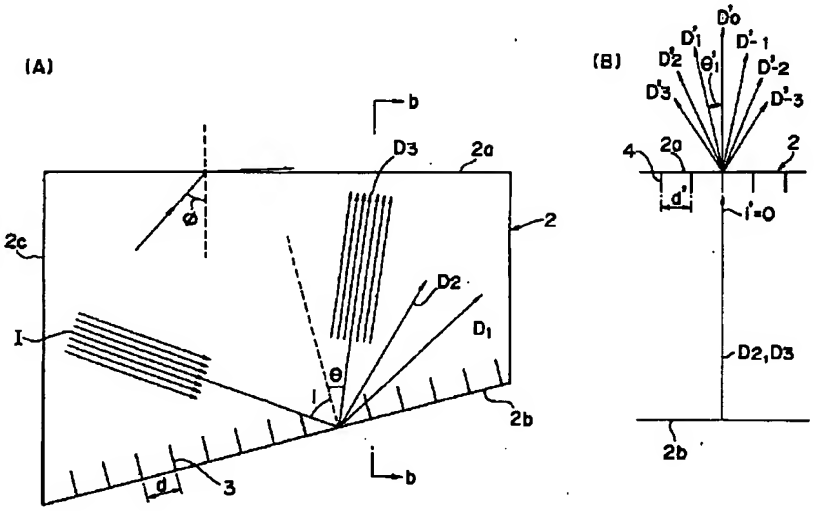
【図５】　本発明の請求項２に記載の導光板の一実施の形態を示す斜視図である。

【図６】　従来の平面照光装置を示す断面図である。

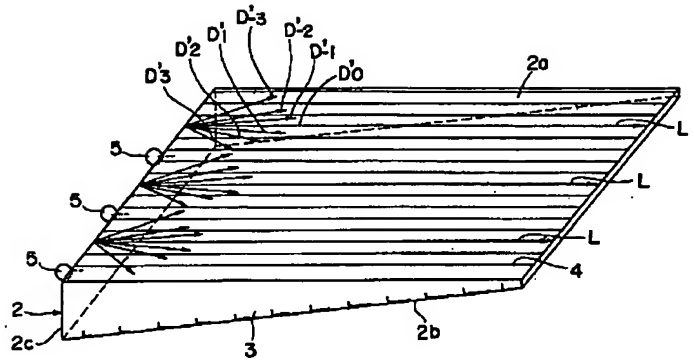
【符号の説明】

１…平面照光装置、２，１２…導光板、２a，１２a…表面、２b，１２b…裏面、２c…厚肉側端辺、３，１３…裏面の回折格子、４，１４…表面の回折格子、５…発光ダイオード、３５…リフレクタ、３６…拡散板、４０…液晶表示パネル。

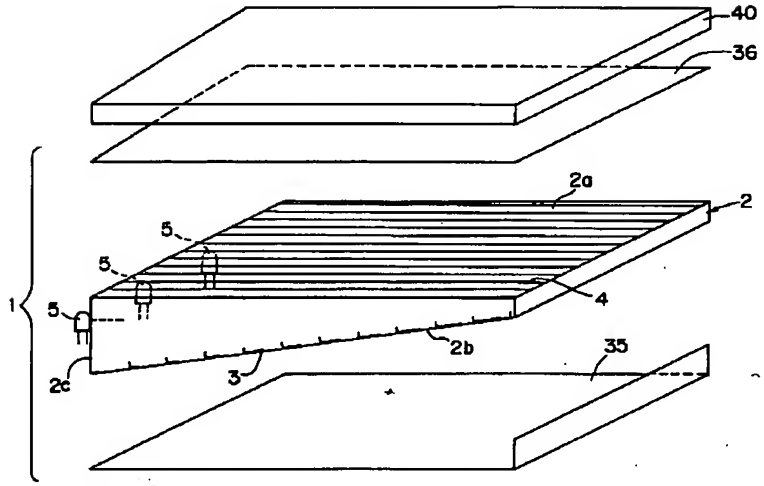
【図１】



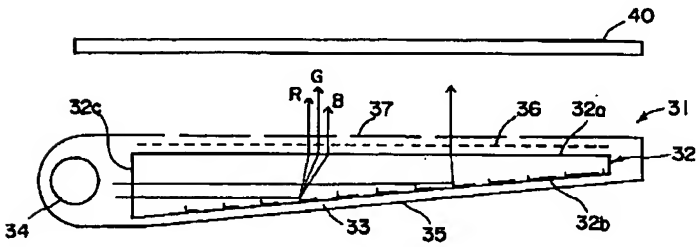
【図２】


D'3
D'2
D'1
D'-3
D'-2
D'-1
D'0
2a
L
L
L
5
5
5
4
2
2c
3
2b

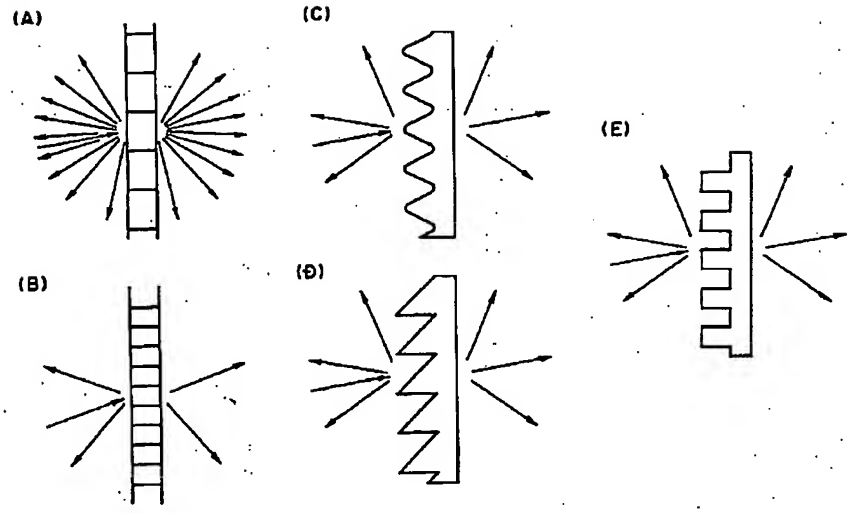
【図３】


40
36
2a
2
5
5
5
1
4
2b
35
3
2c

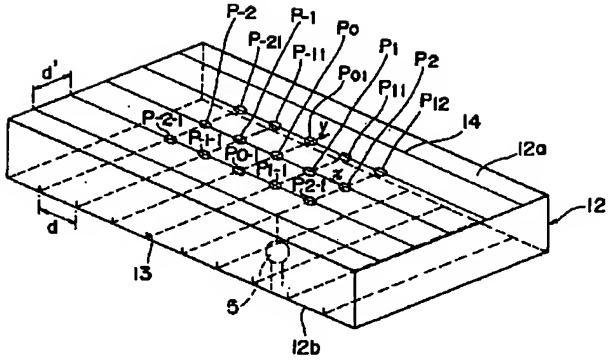
【図６】


40
G
R
B
37
36
32a
31
32c
32
34
33
35
32b

【図４】



【図５】



【手続補正書】
【提出日】平成１１年７月１日
【手続補正１】
【補正対象書類名】明細書
【補正対象項目名】請求項１
【補正方法】変更
【補正内容】
【請求項１】　透明な板状体の少なくとも一端面から入射する１以上の点光源からの光を、上記板状体の裏面に設けられた回折格子と上記板状体の表面に設けられた回折格子によって回折させる導光板であって、
上記裏面の回折格子の単位幅における格子部幅／非格子部幅の比または断面形状が変化せしめられ、
上記表面の回折格子が、上記裏面の回折格子に直交して設けられるとともに、この表面の格子の格子間隔が上記裏面の回折格子の平均格子間隔よりも小さい一定値に設定され、または上記表面の回折格子の断面形状が高次の回折光を高効率で回折する一定形状に設定されていて、
上記導光板の表面における均一で高い輝度が得られるようになっていることを特徴とする導光板。
【手続補正２】
【補正対象書類名】明細書
【補正対象項目名】請求項２
【補正方法】変更
【補正内容】

【請求項２】　透明な板状体の裏面から入射する１以上の点光源からの光を、上記板状体の裏面に設けられた回折格子と上記板状体の表面に設けられた回折格子によって回折させる導光板であって、
上記裏面の回折格子と上記表面の回折格子が、互いに直交して設けられるとともに、上記回折格子の格子間隔または上記回折格子の断面形状が、上記導光板の表面における均一で高い輝度が得られるように設定されていることを特徴とする導光板。
【手続補正３】
【補正対象書類名】明細書
【補正対象項目名】０００９
【補正方法】変更
【補正内容】
【０００９】
【課題を解決するための手段】上記目的を達成するため、請求項１の発明は、透明な板状体の少なくとも一端面から入射する１以上の点光源からの光を、上記板状体の裏面に設けられた回折格子と上記板状体の表面に設けられた回折格子によって回折させる導光板であって、上記裏面の回折格子の単位幅における格子部幅／非格子部幅の比または断面形状が変化せしめられ、上記表面の回折格子が、上記裏面の回折格子に直交して設けられるとともに、この表面の格子の格子間隔が上記裏面の回折格子の平均格子間隔よりも小さい一定値に設定され、または上記表面の回折格子の断面形状が高次の回折光を高効率で回折する一定形状に設定されていて、上記導光板の表面における均一で高い輝度が得られるようになっていることを特徴とする。
【手続補正４】
【補正対象書類名】明細書
【補正対象項目名】００１４
【補正方法】変更
【補正内容】
【００１４】請求項２の発明は、透明な板状体の裏面から入射する１以上の点光源からの光を、上記板状体の裏面に設けられた回折格子と上記板状体の表面に設けられた回折格子によって回折させる導光板であって、上記裏面の回折格子と上記表面の回折格子が、互いに直交して設けられるとともに、上記回折格子の格子間隔または上記回折格子の断面形状が、上記導光板の表面における均一で高い輝度が得られるように設定されていることを特徴とする。